

**U.S. Fish and Wildlife Service
Columbia River Fish and Wildlife Conservation Office**

**Monitoring and Evaluation of Mitchell Act-
Funded National Fish Hatcheries in the Columbia
River Gorge Complex**

FY 2017 Annual Report



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***On the cover:** U.S. Fish and Wildlife Service employee, Kyle Hanson, processes blood samples taken from juvenile upriver bright fall Chinook salmon as part of a study to determine the rate of precocial males being released from Willard National Fish Hatchery.*

Disclaimers

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MONITORING AND EVALUATION OF MITCHELL ACT-FUNDED NATIONAL FISH HATCHERIES IN THE COLUMBIA RIVER GORGE COMPLEX

2017 ANNUAL REPORT

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Abstract

The Mitchell Act was authorized by Congress in 1938 to provide funds for hatchery programs and fish passage facilities to mitigate for declining salmon populations due to irrigation diversions, water pollution, logging, and hydropower development in the Columbia River Basin. Funds are distributed to treaty tribes, states, and federal agencies from the National Oceanic and Atmospheric Administration (NOAA) Fisheries. For National Fish Hatcheries (NFHs) in the Columbia River Gorge Complex, Mitchell Act funds are utilized by four facilities (Carson, Eagle Creek, Little White Salmon, and Willard NFHs) for rearing programs that produce Coho, fall Chinook, and spring Chinook salmon for commercial, tribal, and recreational harvest opportunities. Additionally, funds support egg and juvenile transfer programs, the collection of broodstock, maintenance of facilities, and monitoring and evaluation (M&E) of the programs by the Columbia River Fish and Wildlife Conservation Office. In this report, results from the M&E programs conducted at each of the four facilities over the past ten years is discussed including broodstock need, juvenile production levels, size at release data, marking and tagging information, detection rates at Bonneville Dam, adult returns and smolt-to-adult survival rates inferred from coded-wire tag recoveries, adult age structures, and special studies which are supported by Mitchell Act funds. Recommendations for future studies are also discussed.

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Introduction

In 1938, Congress passed the Mitchell Act to mitigate for declining anadromous fish populations and spawning habitat loss due to irrigation diversions, water pollution, logging, and hydropower development in the Columbia River (NPCC 2008). Mitchell Act funds were used by federal agencies to install fish passage facilities and establish hatchery programs that would provide tribal, recreational, and commercial harvest opportunities in the Pacific Ocean and Columbia River. In 1946, the act was amended to allow funds to be distributed to state agencies for development of salmon resources. In 1947, the Columbia River Fisheries Development Program was established to coordinate the use of Mitchell Act funds in the Columbia River Basin. Presently, the National Oceanic and Atmospheric Administration (NOAA) Fisheries directs funding to agencies in Oregon, Idaho, Washington, treaty tribes, and the U.S. Fish and Wildlife Service (USFWS) for the operation and maintenance of facilities funded by the Mitchell Act (USFWS 2006).

Mitchell Act funds currently support rearing programs at four of the six National Fish Hatcheries (NFHs) in the Columbia River Gorge Complex (Fig. 1). At Carson and Little White Salmon NFHs, Mitchell Act funds support yearling spring Chinook programs. At Eagle Creek NFH, funds are utilized for the rearing, release, and transfer of yearling Coho salmon. Lastly, funds support a subyearling upriver bright Fall Chinook program at Willard NFH. The hatchery programs are operated to be in compliance with the Endangered Species Act (NMFS 2007; NMFS 2017; USFWS 2015), consistent with the 2008-2017 *United States v. Oregon* Management Agreement. Monitoring and evaluation (M&E) of these four programs is conducted by the Columbia River Fish and Wildlife Conservation Office (CRFWCO) located in Vancouver, Washington. The purpose of this report is to summarize results of the M&E programs conducted at each of the facilities over the past ten years, discuss whether facilities are meeting objectives outlined in their Hatchery and Genetic Management Plans (HGMPs), and describe special studies being conducted which have been supported by Mitchell Act funds.



Figure 1. The Columbia River (blue) and the six NFHs of the Columbia River Gorge Complex: Willard, Little White Salmon, Eagle Creek, Carson, Spring Creek, and Warm Springs. Mitchell Act funds currently support rearing programs at four of these facilities.

SECTION 1. Carson NFH: Spring Chinook Program

1.1) Program Description

Carson NFH (Fig. 2) is located at the confluence of Tyee Creek and the Wind River in Skamania County, Washington, approximately 14 miles north of the Columbia River (Fig. 1). The facility became operational in December of 1937, and operates as part of the Columbia River Fisheries Development Program with funding through the Mitchell Act for the spring Chinook rearing program. The spring Chinook program was initiated in 1955 as mitigation for fish losses in the Columbia River Basin due to hydropower development and operation in the mainstem. Current broodstock need for the program is a minimum of 1,500 adults to meet production demands. Presently, 100% of the broodstock is provided by adult returns of hatchery-reared spring Chinook to the facility.



Figure 2. Aerial photograph of Carson NFH located along the Wind River near Carson, WA. U.S. Fish and Wildlife Service stock photograph.

1.2) On-Station Juvenile Production

a) Egg-to-Smolt Survival

Survival objectives during the early life stages are important M&E metrics for determining whether the hatchery is equipped to meet mitigation goals being funded by the Mitchell Act. These survival objectives include:

1. 95% or higher survival from the egg to eye up stage
2. 90% survival from the egg to fry stage; and
3. 97% survival from fry to smolt stage

Mortality can occur during each of these life stages due to disease, injury, predation, starvation, deformities, and genetic anomalies. Hatchery staff monitor these objectives to make sure the facilities are meeting their production levels, and determine whether alternative rearing and release practices are needed to improve on-station survival when warranted.

b) Juvenile Marking, Tagging, and Release Data

Funds distributed from NOAA Fisheries as part of the Mitchell Act are used to meet annual juvenile release goals, process adult returns, for costs associated with PIT tagging, and for equipment maintenance. The facility has an annual release goal of 1,170,000 yearling spring

Chinook salmon into the Wind River. Fish released contribute to sport, commercial, and tribal fisheries while also providing for adequate escapement for hatchery production. The actual number of juveniles produced at Carson NFH has varied by release year (Table 1) with a mean of 1,186,421 million juveniles being annually released since release year (RY) 2008.

Carson NFH has a mean juvenile size goal of 18 fish/lb for an April release of their yearling spring Chinook into the Wind River. Since RY 2008, the facility has achieved a mean juvenile size of 18.96 fish/lb at the time of release. Approximately 8% of the total number of juveniles released are adipose-clipped (AD) and coded-wire tagged (CWT). The remaining 92% of the juveniles released from the facility are AD only. The actual number of juveniles that are mass-marked annually are presented below (Table 1). CWT codes are stored in the USFWS Columbia River Information System (CRiS) database at the CRFWCO and reported annually to the Regional Mark Information System (RMIS).

Table 1. Annual release dates, marking and tagging information, number of juveniles released, and mean juvenile size at release in April for juvenile spring Chinook released from Carson NFH into the Wind River.

Release Year	Release Dates	AD + CWT	AD ONLY	Total Released	Mean Size (fish/lb)
2008	11-Apr	69,432	1,261,404	1,330,836	17.45
2009	13-Apr	74,501	1,141,697	1,216,198	17.04
2010	13-Apr	74,183	1,204,309	1,278,492	17.24
2011	11-, 13-, 14-Apr	138,758	920,013	1,058,771	17.50
2012	16-Apr	139,276	987,089	1,126,365	18.41
2013	17-Apr	138,802	985,240	1,124,042	18.68
2014	16-Apr	135,778	991,234	1,127,012	18.27
2015	15-Apr	73,976	1,084,413	1,158,389	17.38
2016	12-Apr	71,295	1,108,476	1,179,771	25.49
2017	10-Apr	60,524	1,203,811	1,264,335	22.11
Means	Mid-Apr	97,653	1,088,769	1,186,421	18.96

The facility also annually transfers approximately 250,000 yearling spring Chinook (Table 2) to the Confederated Tribes of the Umatilla Indian Reservation for reintroduction of spring Chinook to the Walla Walla River.

Table 2. Annual transfer dates, marking and tagging information, and total number of yearling spring Chinook transferred to the Walla Walla from Carson NFH.

Transfer Year	Transfer Location	Transfer Dates	AD + CWT	AD ONLY	Total # Transferred
2009	Walla Walla	31-Mar	49,658	198,650	248,308
2010	Walla Walla	30-Mar	50,070	199,296	249,366
2011	Walla Walla	11,12-Apr	50,163	182,191	232,354
2012	Walla Walla	2,3-Apr	49,872	199,322	249,194
2013	Walla Walla	1,2,3-Apr	50,041	198,906	248,947
2014	Walla Walla	31-Mar, 1-Apr	49,710	198,445	248,155
2015	Walla Walla	30,31-Mar	50,099	197,488	247,587
2016	Walla Walla	29-Mar	48,393	192,366	240,759
2017	Walla Walla	28-Mar	49,878	199,353	249,231

1.3) Off-Station Juvenile Migration and Survival

a) PIT Tagging Program

PIT tagging provides real-time tracking data as fish migrate from the Wind River to the Columbia River, over Bonneville Dam (BONN), and to the Pacific Ocean. All data is stored in a regional database called the Columbia Basin PIT Tag Information System (PTAGIS) which is utilized by staff at CRFWCO to estimate juvenile post-release migration and survival, track adult returns, and estimate stray rates. In RYs 2008-2010, approximately 15,000 juvenile spring Chinook were annually tagged with passive integrated transponder (PIT) tags just prior to release from Carson NFH (Table 3). Tagging rates increased to nearly 30,000 for four years (RYs 2011-2014) before returning to 15,000 juveniles per year beginning in RY 2015. Financial support for PIT tagging juveniles at Carson NFH has been provided by Bonneville Power Administration (as part of a comparative survival study), the USFWS, and Mitchell Act funds.

The facility has an annual mean of 20,653 juveniles that have been tagged since RY 2008. The detection rate of PIT tagged fish at BONN is a function of a) migration survival from release to BONN and b) the detection efficiency of the PIT antenna arrays at the dam. A mean of 2,375 PIT tagged juveniles have been detected at BONN for a mean detection rate of 11.77%. Mean juvenile travel time to BONN after release is approximately 17.13 days with some juveniles spending up to 237 days between the facility and BONN before migrating downstream. However, the majority of fish (90th percentile) pass over BONN within 31 days after release.

Table 3. The number of juvenile spring Chinook PIT tagged in a given release year and travel times to BONN following release from Carson NFH.

Release Year	# PIT Tagged	# Detected at BONN	% Detected	Travel Time (Days)					
				Mean	Median	Range	Percentile		
							50th	75th	90th
2008	14,884	1,884	12.66	20.12	18.00	(1 - 90)	18	27	35
2009	14,975	1,867	12.47	22.67	23.00	(1 - 106)	23	31	37
2010	14,940	2,805	18.78	20.08	21.00	(1 - 91)	21	27	31
2011	29,548	2,968	10.04	18.42	21.00	(1 - 99)	21	28	31
2012	29,479	2,951	10.01	16.84	10.00	(0.5 - 237)	10	23	55
2013	29,582	3,818	12.91	18.35	15.00	(1 - 111)	15	20	26
2014	29,406	2,946	10.02	17.39	18.00	(2 - 106)	18	23	28
2015	14,734	2,299	15.60	15.72	17.00	(1 - 75)	17	19	21
2016	14,019	1,060	7.56	10.16	9.00	(1 - 79)	9	15	19
2017	14,967	1,150 ^a	7.68	11.52	9.00	(1 - 104)	9	17	24
Means	20,653	2,375	11.77	17.13	16.10	-	16	23	31

^aCurrent estimate as of 9/15/2017.

1.4) Adult Returns, Harvest Data, and Smolt-to-Adult Survival

Adult returns to Carson NFH are estimated by hatchery personnel and the marking and biosampling crew from CRFWCO. CWT recoveries maintained in the RMIS database are used to estimate the number of harvested adults and spawning ground recoveries (Table 4). At Carson NFH, the number of hatchery returns and harvested adults has fluctuated since brood year (BY) 2001 with no reported adult recoveries from spawning grounds. Collectively, the facility has produced a mean of 5,962 adults annually since BY 2001 resulting in a mean smolt-to-adult survival rate of 0.465% which is near the 10-year average goal of 0.5% set in the facility's Hatchery and Genetic Management Plan (HGMP; USFWS 2004a).

Table 4. The estimated number of hatchery returns, harvested adults, and fish present on the spawning grounds based on coded wire tag recovery expansion data from RMIS for spring Chinook released from Carson NFH. Adult returns are used to estimate smolt-to-adult survival rates.

Brood Year	Hatchery Returns^a	Columbia River Harvest	Ocean Harvest	Spawning Grounds	Total # of Adults	Smolt-to-Adult Survival (%)
2001	1,816	2,426	20	0	4,262	0.255
2002	2,675	2,451	0	0	5,126	0.362
2003	1,702	1,128	0	0	2,830	0.193
2004	1,648	4,924	0	0	6,572	0.543
2005	1,935	3,279	0	0	5,214	0.450
2006	6,102	9,710	0	0	15,812	1.188
2007	3,093	2,363	57	0	5,513	0.453
2008	1,909	5,506	0	0	7,415	0.580
2009	1,725	737	0	0	2,462	0.233
2010	2,784	1,632	0	0	4,416	0.392
Means	2,539	3,416	8	0	5,962	0.465

^a*Hatchery return estimates include returns to Carson NFH and strays recovered at other hatcheries.*

Monitoring adult returns to the hatchery provides information on sex ratios, length information, and age structure. Aging is determined by USFWS staff through CWT recoveries and scale sampling. Since RY 2007, approximately 88% of adults have returned to the facility at Age-4 (Table 5). Additionally, approximately 7% have returned as jacks at Age-3, and almost 6% have returned at Age-5. No Age-2 or Age-6 returns have been documented. The facility has a mean of 2,308 adult returns each year.

Table 5. Age structure of adult spring Chinook returns to Carson NFH. Aging for RY 2017 has not yet been completed.

Return Year	Age-2	Age-3	Age-4	Age-5	Age-6	Total Adults
2007	0	80	1,269	298	0	1,647
2008	0	88	1,218	112	0	1,418
2009	0	412	1,972	67	0	2,451
2010	0	196	4,114	62	0	4,372
2011	0	176	2,734	185	0	3,095
2012	0	26	1,437	149	0	1,612
2013	0	223	1,507	183	0	1,913
2014	0	199	2,126	91	0	2,416
2015	0	138	2,671	32	0	2,841
2016	0	40	1,174	104	0	1,318
Means	0	158	2,022	128	0	2,308

1.5) Special Studies

Staff at the CRFWCO conducted a study (brood years 2009-2012) evaluating the effects of PIT tagging on post-release survival (USFWS 2013). The last year of adult sampling for the study was conducted at the hatchery in 2017. Reporting and publication of findings from the study are planned for 2018. No other special studies as part of the M&E program are currently being conducted. However, the hatchery staff continually monitor the Bacterial Kidney Disease (BKD) issues with their broodstock, and cull eggs from females with high occurrences of BKD. Additionally, hatchery staff continue to include the CRFWCO in discussions about the monitoring and potential eradication of Brook trout from Tyee Springs.

SECTION 2. Eagle Creek NFH: Coho Program

2.1) Program Description

Eagle Creek NFH (Fig. 3) is located at river kilometer (rkm) 16 on Eagle Creek, a tributary of the Clackamas River near Estacada, Oregon. The Clackamas River connects with the Willamette River which then flows into the Columbia River at rkm 163 (Fig. 1). The hatchery became operational in 1956 with the primary role of mitigating for habitat loss due to operation of BONN by supporting commercial and recreational fisheries as authorized under the Mitchell Act. Currently, the facility annually rears and releases yearling Coho salmon into Eagle Creek and assists with the Yakima Nation and Nez Perce tribes' reintroduction efforts by providing yearling Coho salmon for these programs. Current broodstock need for the Coho program at Eagle Creek NFH is a minimum of 1,600 adults to meet juvenile production and transfer demands, and is provided by adult returns to the facility. Additionally, the facility propagates winter-run steelhead and spring Chinook under an agreement with the Oregon Department of Fish and Wildlife (ODFW). The ODFW steelhead and spring Chinook programs are not included in this report.



Figure 3. Aerial photograph of Eagle Creek NFH located on Eagle Creek, a tributary of the Clackamas River near Estacada, Oregon. U.S. Fish and Wildlife Service stock photograph.

2.2) On-Station Juvenile Production

a) Egg-to-Smolt Survival

The survival objectives for the facility are the same as Carson NFH (section 1.2a). Hatchery staff at Eagle Creek NFH monitor these objectives to make sure the facilities are meeting their production goals, and design alternative rearing and release practices to improve on-station survival as needed.

b) Juvenile Marking, Tagging, and Release Data

Mitchell Act funds support juvenile production costs including the PIT tagging and transfer of juveniles to other facilities and programs. Prior to RY 2009, the facility was rearing and releasing 500,000 juvenile Coho into Eagle Creek annually. However, production goals were

changed to 350,000 juvenile Coho on-station releases beginning with RY 2009 (BY 2007). The actual number of juvenile Coho released into Eagle Creek has varied by release year (Table 6) with an annual mean of 359,346 juveniles released since RY 2008.

Eagle Creek NFH has a mean juvenile size goal of 12 fish/lb for a mid-April release of their yearling Coho salmon. Since RY 2008, the facility has achieved a mean juvenile size of 16.63 fish/lb at the time of release. Approximately 6.5% of the total number of juveniles that are released from the facility are AD and CWT. Another 6.5% is CWT only (Double Index Tagged, DIT fish) which is used to assess the impact of fishing pressures on wild populations. The remaining 86% of the juvenile Coho releases are AD only. The actual number of juveniles that are marked and tagged varies each year (Table 6). All CWT codes are stored in the USFWS CRiS database at the CRFWCO and reported annually to RMIS.

Table 6. Annual release dates, marking and tagging information, total number of juveniles released, and mean juvenile size for Coho released from Eagle Creek NFH.

Release Year	Release Dates	AD + CWT	CWT (DIT)	AD ONLY	Total Released	Mean Size (fish/lb)
2008	7-Apr	17,825	18,733	474,784	511,342	15.57
2009	10-Apr	25,069	24,925	274,950	324,944	20.48
2010	12-Apr	24,815	24,825	305,972	355,612	13.91
2011	11-Apr	24,850	24,834	272,207	321,891	15.79
2012	1-May	24,534	24,312	296,154	345,000	16.81
2013	18-Apr	25,006	23,656	333,907	382,569	16.69
2014	16-Apr	24,084	22,594	321,314	367,992	15.95
2015	3-Apr	14,905	23,654	292,674	331,233	16.65
2016	30-Mar	23,515	23,326	261,815	308,656	15.75
2017	11-Apr	24,301	21,603	298,312	344,216	18.70
Means	Mid-Apr	22,890	23,246	313,209	359,346	16.63

The facility also has transfer goals of 500,000 yearlings to the Confederated Tribes and Bands of the Yakama Nation for reintroduction efforts in the Yakima River region, and 550,000 yearlings to the Nez Perce Tribe for reintroduction efforts in the Clearwater River region. These transferred fish are marked and/or tagged by staff at the CRFWCO prior to transfer, but any release information after transfer would be reported to RMIS from the Yakama Nation or Nez Perce Tribe. Eagle Creek NFH will continue to support these reintroduction programs until transfers are no longer needed.

2.3) Off-Station Juvenile Migration and Survival

At Eagle Creek NFH, no PIT tagging of the on-station juvenile releases is conducted given that juveniles migrate to the Pacific Ocean through the Clackamas, Willamette, and Columbia Rivers without passing over any major PIT tag detection locations. However, since RY 2010, approximately 10,000 juvenile Coho have been PIT tagged annually just prior to transfer to the Nez Perce program (Table 7).

Table 7. Tagging dates and number of juvenile Coho PIT tagged prior to transfer to the Nez Perce program.

Release Year	Tagging Dates	# PIT Tagged
2010	19,20-Jan	9,957
2011	19,20-Jan	9,991
2012	18,19,20-Jan	9,959
2013	14,15,16-Jan	9,979
2014	21,22,23-Jan	9,986
2015	12,13,14-Jan	9,922
2016	25,27-Jan	9,993
2017	28,29-Jan	4,992 ^a

^aApproximately 5K juveniles PIT tagged given low juvenile numbers.

2.4) Adult Returns, Harvest Data, and Smolt-to-Adult Survival

For Coho released from Eagle Creek NFH, the number of hatchery returns, harvested adults, and spawning ground recoveries have fluctuated since BY 2001 (Table 8). Approximately 18% of adults are harvested in the Pacific Ocean as opposed to the 5% harvested in the Columbia River Basin. The facility has produced a mean of 7,540 adults annually since BY 2001 with a smolt-to-adult survival rate of 1.665% which is near the 10-year average goal of 2% set for the Coho program in the HGMP (USFWS 2004b).

Table 8. The estimated number of hatchery returns, harvested adults, and fish present on the spawning grounds based on coded wire tag recovery expansion data from RMIS for Coho released from Eagle Creek NFH. Adult returns are used to estimate smolt-to-adult survival rates.

Brood Year	Hatchery Returns^a	Columbia River Harvest	Ocean Harvest	Spawning Ground	Total # of Adults	Smolt-to-Adult Survival (%)
2001	5,170	360	640	21	6,191	1.225
2002	7,322	386	572	0	8,280	1.487
2003	4,477	580	1,001	23	6,081	1.160
2004	10,145	634	3,418	73	1,4270	3.106
2005	3,399	339	444	2	4,184	0.792
2006	11,425	1,530	5,243	55	18,253	3.570
2007	1,005	87	204	24	1,320	0.406
2008	1,418	123	146	26	1,713	0.482
2009	873	168	132	0	1,173	0.364
2010	3,372	81	442	0	3,895	1.129
2011	14,899	76	2,606	0	17,581	4.596
Means	5,773	397	1,350	20	7,540	1.665

^aHatchery return estimates include returns to Eagle Creek NFH and strays recovered at other hatcheries.

Aging of adult Coho returns to Eagle Creek NFH are determined using CWT recoveries and scale sampling as noted for Carson NFH. However, the vast majority (~91%) of adult Coho return as Age-3 fish with a small proportion (~9%) of fish returning as jacks at Age-2 (Table 9). Zero Age-4, Age-5, or Age-6 returns have been documented. The facility has an annual mean of 7,019 adult returns to the facility since RY 2007.

Table 9. Age structure of adult Coho returns to Eagle Creek NFH. Aging for RY 2017 has not yet been completed.

Return Year	Age-2	Age-3	Age-4	Age-5	Age-6	Total Adults
2007	104	10,951	0	0	0	11,055
2008	644	5,997	0	0	0	6,641
2009	70	7,859	0	0	0	7,929
2010	14	1,865	0	0	0	1,879
2011	60	2,130	0	0	0	2,190
2012	214	1,132	0	0	0	1,346
2013	522	3,382	0	0	0	3,904
2014	257	15,757	0	0	0	16,014
2015	2,215	13,799	0	0	0	16,014
2016	1,920	1,293	0	0	0	3,213
Means	602	6,417	0	0	0	7,019

2.5) Special Studies

No special studies as part of the Coho M&E program are currently being conducted at Eagle Creek NFH. From 2005 through 2015, the USFWS conducted multiple year evaluations investigating the ecological and genetic interactions of hatchery and wild steelhead in Eagle Creek (Kavanagh et al. 2009; Kavanagh et al. 2017). Brignon (2017) is an example of a recent publication from these evaluations.

SECTION 3. Little White Salmon NFH: Spring Chinook Program

3.1) Program Description

Little White Salmon NFH (Fig. 4) is located on the Little White Salmon River just upstream of Drano Lake, a small body of water that converges with the Columbia River at rkm 261. The facility is the oldest NFH in the Pacific Region (Fig. 1) becoming operational in 1898 to support the commercial fishing industry. In the late 1930s, the facility began receiving Mitchell Act funds to mitigate for habitat loss due to the completion of BONN. Mitchell Act funds are currently used for the annual production and PIT tagging of spring Chinook salmon into the Little White Salmon River as well as the transfer of upriver bright fall Chinook eggs to Willard NFH and the Yakama Nation's Klickitat Hatchery. Additionally, the facility has an upriver bright fall Chinook program with funding from the U.S. Army Corps of Engineers as part of the John Day/The Dalles Dam Mitigation (JDTD) Program. Broodstock need for the spring Chinook program at Little White Salmon NFH is a minimum of 1,000 adults. Currently, the broodstock need is met through adult returns to the facility.



Figure 4. Aerial photograph of Little White Salmon NFH located on the Little White Salmon River in Cook, WA. U.S. Fish and Wildlife Service stock photograph by Speros Doulos.

3.2) On-Station Juvenile Production

a) Egg-to-Smolt Survival

The survival objectives for the facility are the same as Carson NFH (section 1.2a). Hatchery staff at Little White Salmon NFH monitor these objectives to make sure the facilities are meeting their production goals, and design alternative rearing and release practices to improve on-station survival as needed.

b) Juvenile Marking, Tagging, and Release Data

Funds received from NOAA Fisheries under the Mitchell Act are used to cover juvenile production and PIT tagging expenses, general facility maintenance costs, processing of adult returns, and egg transfer requests. The program has an annual juvenile release goal of 1,000,000 yearling spring Chinook. Since RY 2008, the program has produced an annual mean of

1,039,206 yearling spring Chinook that were released into the Little White Salmon River in mid-April (Table 10). From 2009 to 2014, a proportion of the program's juvenile production was reared and released from Willard NFH into the Little White Salmon River.

Approximately 10% of juveniles were AD and CWT. The remaining 90% of fish were AD only just prior to release (Table 10). All CWT codes are stored in the CRiS database and reported to RMIS. Since RY 2008, the facility has achieved a mean juvenile size of 15.32 fish/lb which is near the program's goal of 15 fish/lb at release listed in the HGMP (USFWS 2015).

Table 10. Annual release dates, marking and tagging information, total number of juveniles released, and mean juvenile size for spring Chinook reared at Little White Salmon (LWS) NFH or Willard (WI) NFH, and released into the Little White Salmon River.

Release Year	Release Site	Release Dates	AD + CWT	AD ONLY	Total Released	Mean Size (fish/lb)
2008	LWS	17-Apr	113,764	820,674	934,438	14.78
2009	LWS	16-Apr	71,221	519,542	590,763	15.02
	WI	16-Apr	75,394	349,175	424,569	16.51
2010	LWS	15-Apr	72,614	512,189	584,803	15.26
	WI	15-Apr	74,970	350,571	425,541	15.20
2011	LWS	14-Apr	67,861	532,872	600,733	15.27
	WI	14-Apr	74,062	325,891	399,953	15.40
2012	LWS	19-Apr	74,304	684,857	759,161	14.99
	WI	19-Apr	24,677	221,827	246,504	15.43
2013	LWS	18-Apr	73,511	652,214	725,725	15.30
	WI	18-Apr	24,266	271,816	296,082	15.50
2014	LWS	17-Apr	73,487	802,166	875,653	15.28
	WI	17-Apr	9,738	112,997	122,735	16.48
2015	LWS	16-Apr	73,946	925,259	999,205	14.84
2016	LWS	14-Apr	73,539	1,250,120	1,323,659	14.91
2017	LWS	12-Apr	74,475	1,008,064	1,082,539	15.84
Means	LWS/WI	Mid-Apr	105,183	934,023	1,039,206	15.32

Little White Salmon NFH does not transfer any spring Chinook yearlings as part of the Mitchell Act funded program; however, the facility does use Mitchell Act funds to transfer approximately 2.2 million upriver bright eggs to Willard NFH to support their Mitchell Act funded program, and up to 5.0 million upriver bright eggs to the Yakama Nation to support their Klickitat Hatchery program.

3.3) Off-Station Juvenile Migration and Survival

a) PIT Tagging Program

Since RY 2008, an annual mean of 14,960 yearling spring Chinook have been PIT tagged at either Little White Salmon NFH or Willard NFH as part of the Little White Salmon NFH spring Chinook program (Table 11). Approximately 14% of PIT tagged yearling spring Chinook released from Little White Salmon NFH and 12% released from Willard NFH have been detected annually at BONN. On average, yearlings took approximately 15.5 days after release from Little White Salmon NFH and 26 days after release from Willard NFH to be detected at

BONN. The majority of yearlings (90th percentile) released from Little White Salmon NFH passed over BONN within 27 days after release versus 35 days after release from Willard NFH.

Table 11. The number of juvenile spring Chinook PIT tagged in a given release year (RY) at Little White Salmon (LWS) and Willard (WI) NFHs, and travel times to BONN following release into the Little White Salmon River.

RY	Release Site	# PIT Tagged	# Detected at BONN	% Detected	Travel Time (Days)					
					Mean	Median	Range	Percentile		
								50th	75th	90th
2008	LWS	14,941	2,694	18.03	21.93	21.00	(0.5 – 116)	21	26	31
2009	LWS	7,492	983	13.12	16.77	10.00	(1 – 89)	10	24	32
	WI	7,498	984	13.12	31.00	29.00	(2 – 113)	29	33	47
2010	LWS	7,467	1,399	18.74	15.13	17.00	(1 – 78)	17	23	27
	WI	7,453	1,420	19.05	26.02	26.00	(3 – 91)	26	30	34
2011	LWS	7,482	885	11.83	18.51	20.00	(1 – 108)	20	29	32
	WI	7,490	589	7.86	26.65	29.00	(3 – 87)	29	32	35
2012	LWS	11,959	1,059	8.86	13.40	8.00	(1 – 83)	8	19	26
	WI	2,961	281	9.49	25.13	26.00	(4 – 72)	26	29	33
2013	LWS	10,480	1,426	13.61	17.74	13.00	(1 – 109)	13	18	36
	WI	4,494	500	11.13	23.57	22.00	(4 – 96)	22	25	30
2014	LWS	11,991	1,353	11.28	13.40	12.00	(0.5 – 93)	12	20	25
	WI	2,993	311	10.39	23.37	24.00	(4 – 89)	24	28	31
2015	LWS	14,945	2,879	19.26	14.36	15.00	(0.5 – 83)	15	18	20
2016	LWS	14,974	2,142	14.30	11.67	10.00	(1 – 95)	10	15	19
2017	LWS	14,979	1,225 ^a	8.18	12.11	10.00	(0.5 – 76)	10	17	23
Means	LWS	14,960	1,605	13.72	15.50	13.60	-	14	21	27
	WI		681	11.84	25.96	26.00		26	30	35

^aCurrent estimate as of 9/15/2017.

3.4) Adult Returns, Harvest Data, and Smolt-to-Adult Survival

The number of adult returns to the facility were estimated annually by hatchery personnel and the marking and biosampling crew from the CRFWCO. CWT recoveries obtained from RMIS are used to estimate the number of harvested adults and adults recovered on the spawning grounds. Since BY 2001, the number of adult hatchery returns has varied from 540 to 4,424 adults (Table 12). Approximately 55% of adult returns are harvested in the Columbia River with less than 1% on average being harvested in the ocean and less than 4% being observed on the spawning grounds. The facility has produced a mean of 5,695 adult spring Chinook since BY 2001 with a smolt-to-adult survival rate of 0.582% which is greater than the 0.2% rate set in the HGMP (USFWS 2004c).

Table 12. The estimated number of hatchery returns, harvested adults, and fish present on the spawning grounds based on coded wire tag recovery expansion data from RMIS for spring Chinook released from Little White Salmon NFH. Adult returns are used to estimate smolt-to-adult survival.

Brood Year	Hatchery Returns^a	Columbia River Harvest	Ocean Harvest	Spawning Ground	Total # of Adults	Smolt-to-Adult Survival (%)
2001	540	510	0	0	1,050	0.104
2002	3,493	3,017	105	35	6,650	0.641
2003	1,062	1,434	0	0	2,496	0.320
2004	2,530	2,735	0	10	5,275	0.520
2005	2,120	4,624	0	8	6,752	0.671
2006	4,408	14,408	0	240	19,056	2.039
2007	1,104	1,824	0	712	3,640	0.359
2008	1,784	1,480	0	8	3,272	0.324
2009	1,719	576	0	0	2,295	0.229
2010	2,430	2,240	20	1,390	6,080	0.605
2011	4,424	1,656	0	0	6,080	0.595
Means	2,329	3,137	11	218	5,695	0.582

^a*Hatchery return estimates include returns to Little White Salmon NFH and strays recovered at other hatcheries.*

Similar to Carson and Eagle Creek NFHs, aging of adult returns to Little White Salmon NFH are determined using CWT recoveries and scale sampling. On average, the majority (~86%) of spring Chinook return to Little White Salmon NFH as Age-4 adults (Table 13). Approximately 4% return as jacks at Age-3 and almost 10% of adults return the facility at Age-5. No Age-2 or Age-6 adults have been documented. The facility has a mean of 3,790 adult returns each year.

Table 13. Age structure of adult spring Chinook returns to Little White Salmon NFH. Aging for RY 2017 has not been completed.

Return Year	Age-2	Age-3	Age-4	Age-5	Age-6	Total Adults
2007	0	188	1,764	787	0	2,739
2008	0	287	3,009	456	0	3,752
2009	0	343	2,123	73	0	2,539
2010	0	53	5,181	145	0	5,379
2011	0	34	1,589	145	0	1,768
2012	0	24	2,485	382	0	2,891
2013	0	88	2,732	854	0	3,674
2014	0	67	2,773	127	0	2,967
2015	0	183	7,270	333	0	7,786
2016	0	116	3,832	456	0	4,404
Means	0	138	3,276	376	0	3,790

3.5) Special Studies

No special studies as part of the spring Chinook M&E program are currently being conducted at Little White Salmon NFH; however, potential future studies may build upon previous work assessing the: 1) influence of rearing densities on juvenile survival and 2) determining the influence of feeding regimes on precocial male maturation rates.

SECTION 4. Willard NFH: Upriver Bright Fall Chinook Program

4.1) Program Description

Willard NFH (Fig. 5) is located on the Little White Salmon River approximately 6.5 rkm upstream of Little White Salmon NFH (Fig. 1). The facility began rearing upriver bright fall Chinook with funding from the Mitchell Act in 2013. The purpose of the upriver bright program at Willard NFH is to provide adults for harvest as mitigation for hydropower development on the mainstem of the Columbia River. A natural waterfall at Little White Salmon NFH prevents all adults from passing upstream to Willard NFH so broodstock need is provided by hatchery returns to Little White Salmon NFH. Current broodstock need to meet Willard NFHs juvenile release goals set by the USFWS is a minimum of 500 females or approximately 2.2 million eggs. Little White Salmon NFH has been successfully fulfilling this broodstock need since BY 2013.



Figure 5. Willard NFH is located on the Little White Salmon River near Willard, WA. U.S. Fish and Wildlife Service stock photograph by Cheri Anderson.

4.2) On-Station Juvenile Production

a) Egg-to-Smolt Survival

The survival objectives for the facility are the same as Carson NFH (section 1.2a). Hatchery staff at Willard NFH monitor these objectives to make sure the facilities are meeting their production goals, and design alternative rearing and release practices to improve on-station survival as needed.

b) Juvenile Marking, Tagging, and Release Data

Mitchell Act funds support juvenile production and PIT tagging costs as well as facility maintenance. The upriver bright program has a release goal of 2,000,000 juvenile fall Chinook. Since RY 2014, Willard NFH has produced a mean of 1,780,088 sub-yearling, upriver bright fall Chinook that were released into the Little White Salmon River in mid to late July (Table 14). Approximately 5.5% of these juveniles were AD and CWT, and another 5.5% were CWT only (DIT fish). The remaining 89% of juveniles were AD only prior to release. All CWT codes used

are stored in the USFWS CRiS database at the CRFWCO and reported to RMIS. Since RY 2014, the facility has achieved a mean juvenile size of 93.56 fish/lb which is near the program's goal of 70-90 fish/lb at release listed in the HGMP (USFWS 2004d).

Table 14. Annual release dates, mass marking information, total number of juveniles released, and mean juvenile size for upriver bright fall Chinook released from Willard NFH.

Release Year	Release Dates	AD + CWT	CWT (DIT)	AD ONLY	Total Released	Mean Size (fish/lb)
2014	28-Jul	99,960	99,965	1,673,335	1,873,260	94.43
2015	1-Jul	100,029	100,038	1,603,197	1,803,264	81.82
2016	11-Jul	100,039	100,083	1,360,690	1,560,812	101.48
2017	12-Jul	98,058	100,068	1,684,890	1,883,016	96.52
Means	Mid-Jul	99,522	100,039	1,580,528	1,780,088	93.56

4.3) Off-Station Juvenile Migration and Survival

a) PIT Tagging Program

PIT tagging of juvenile upriver bright fall Chinook prior to release allows CRFWCO staff to monitor juvenile post-release migration time and survival as juveniles migrate to the Columbia River and over BONN to the Pacific Ocean. PIT tag data is also used to determine the timing of adult returns and potential stray rates. PIT tagging of juvenile upriver brights at Willard NFH began in RY 2015. Since then, the facility has annually PIT tagged a mean of 14,963 juveniles (Table 15). Approximately 3.76% of PIT tagged juveniles have been detected at BONN. On average, juveniles take approximately 14.55 days to reach BONN with the majority of juveniles (90th percentile) passing over BONN within 21 days after release. However, some individuals have spent up to 89 days between the facility and BONN before being migrating downstream.

Table 15. The number of juvenile upriver bright fall Chinook PIT tagged in a given release year and travel times to BONN following release from Willard NFH.

Release Year	# PIT Tagged	# Detected at BONN	% Detected	Travel Time (Days)					
				Mean	Median	Range	Percentile		
							50th	75th	90th
2015	14,934	432	2.89	19.96	18	(5 - 89)	18	23	30
2016	14,982	578	3.86	13.55	13	(3 - 45)	13	15	17
2017	14,973	677 ^a	4.52	10.13	9	(1 - 40)	9	13	17
Means	14,963	562	3.76	14.55	13	-	13	17	21

^aCurrent estimate as of 9/15/2017.

4.4) Adult Returns, Harvest Data, and Smolt-to-Adult Survival

Adults that were released from Willard NFH as juveniles in 2015 are expected to begin returning to Little White Salmon NFH this fall. CWT recoveries will be monitored to determine whether the Willard NFH program is meeting the smolt-to-adult survival rate of 0.32% set in the HGMP (USFWS 2004d), and successfully contributing to the 10-year average goal of 2,680 adults that the program is expected to provide for harvest.

4.5) Special Studies

a) Feeding Influences on Precocial Male Maturation in Upriver Bright Fall Chinook

Despite a rise in empirical work on precocial maturation in the Columbia River Basin, few studies have examined the influence of feeding rates on precocial male maturation in fall (ocean-type) Chinook salmon. Additionally, while jack rates have been consistently quantified, precocial parr and minijack rates are unknown. As part of a special study at Willard NFH during 2017, we examined the influence of a standard versus a reduced feeding regime on precocial parr, minijack, and jack production for subyearling, upriver bright fall Chinook salmon. From March 27th to May 18th, four raceways of subyearling fall Chinook were fed 4 days per week and an additional four raceways were fed 7 days per week. From May 18th until fish were released in mid-July, all raceways were fed 7 days a week. Fish were sampled three times throughout the study to quantify mean body length, mean weight, and mean whole body lipid content. Additionally, blood samples were taken from juveniles just prior to release to quantify precocial parr rates, and gill samples were taken to determine smoltification rates. Approximately 500 fish from each of the eight raceways were PIT tagged and CWT to monitor minijack and jack rates. Results will be made available as a report and potentially submitted to a journal for publication when all samples have been processed and adult return data has been collected.

Summaries and Future Studies

Collectively, the four facilities in the Columbia River Gorge Complex with programs funded through the Mitchell Act are sufficiently meeting objectives identified in their respective HGMPs. Based on the 10-year-averages, Carson, Eagle Creek, and Little White Salmon have slightly exceeded their production goals set under *U.S. v. Oregon* agreements, but all have remained within 5% of their target number. All programs have successfully collected enough eggs or produced enough juveniles to either meet or be close to meeting their transfer goals to other programs or facilities. Additionally, the programs at Carson, Eagle Creek, and Little White Salmon NFHs have been close to or exceeded their 10-year-average, smolt-to-adult survival rate goals as outlined in their respective HGMPs. In the past 10 years, all programs have produced enough adult returns to sufficiently meet their broodstock needs. Based on the aging structure of adult returns, jack rates at the facilities are low (i.e. ranging from 4-7%) which indicates the majority of adults produced by these Mitchell Act-funded programs are large, mature adults. Therefore, all programs appear to be producing adults that contribute to harvest opportunities.

a) Notable Trends

Based on the PIT tag detection data, juvenile upriver bright fall Chinook released from Willard NFH have the lowest detection rates (average of <4%) at BONN of any program. Additionally, detection rates are roughly half the number when compared to detection rates for upriver bright fall Chinook released from Little White Salmon NFH at nearly the same time (Dammerman 2016). Residualism within the Little White Salmon River may be a concern for the upriver bright program at Willard NFH given the high fat content observed in juveniles just prior to release. The feeding study conducted at the facility was also conducted to address whether the upriver brights are precocially maturing and residualizing within the river instead of smolting and migrating over BONN to the Pacific Ocean. Predation within the Little White Salmon River between Willard and Little White Salmon NFHs may also be a contributing factor. Strategies to address this concern are being discussed including the feasibility of trucking juveniles down to

Little White Salmon NFH and releasing them from that facility. This strategy would allow comparisons to still be made between PIT tag detection rates at BONN for juveniles that were reared at Willard NFH and those reared at Little White Salmon NFH.

b) Future M&E Studies

As part of NOAA's recent Biological Opinion (NMFS 2017), quantification of precocity (early sexual maturation) rates at facilities with Mitchell Act funded programs is being required as an additional monitoring metric. At Carson, Little White Salmon, Eagle Creek, and Willard NFHs, jack rates are already being quantified through monitoring of adult returns. Additionally, PIT tag detection data for the fish reared at Carson, Little White Salmon, and Willard NFHs can provide insight on minijack rates, but have not been actively monitored. Therefore, a future objective for the M&E program is to develop a standardized protocol for quantifying minijack rates in order to accurately predict and monitor precocial male maturation at each of the facilities. Monitoring of PIT tag releases will be used to estimate the number of mini-jack/precocial fish either a) migrating back upstream over BONN during the year of release, or b) returning to the hatchery during the year of release. Furthermore, a protocol involving internally examining juvenile fish from each program just prior to release will be developed in order to create a standardized method for documenting precocity at each facility.

Acknowledgements

Data used in this report was downloaded from CRiS maintained at the CRFWCO, RMIS, and PTAGIS. Hatchery personnel at Carson, Eagle Creek, Little White Salmon, and Willard NFHs collected data on release dates, adult returns, and annual number of juveniles released from the facilities. Marking and biosampling crews from the USFWS documented the number of adult returns as well as adipose fin-clipped, coded-wire tagged, and PIT-tagged juveniles prior to release. Funding for M&E of these hatchery programs was provided by the USFWS and funds from the Mitchell Act distributed by NOAA Fisheries.

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